

ORIGINAL ARTICLE

Randomised trial of infant sleep location on the postnatal ward

H L Ball, M P Ward-Platt, E Heslop, S J Leech, K A Brown



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Objective: To determine whether postnatal mother–infant sleep proximity affects breastfeeding initiation and infant safety.

Design: Randomised non-blinded trial analysed by intention to treat.

Setting: Postnatal wards of the Royal Victoria Hospital (RVI), Newcastle upon Tyne, UK.

Participants: 64 newly delivered mother–infant dyads with a prenatal intention to breastfeed (vaginal deliveries, no intramuscular or intravenous opiate analgesics taken in the preceding 24 h).

Intervention: Infants were randomly allocated to one of three sleep conditions: baby in mother's bed with cot-side; baby in side-car crib attached to mother's bed; and baby in stand-alone cot adjacent to mother's bed.

Main outcome measures: Breastfeeding frequency and infant safety observed via night-time video recordings.

Results: During standardised 4-h observation periods, bed and side-car crib infants breastfed more frequently than stand-alone cot infants (mean difference (95% confidence interval (CI)): bed v stand-alone cot = 2.56 (0.72 to 4.41); side-car crib v stand-alone cot = 2.52 (0.87 to 4.17); bed v side-car crib = 0.04 (–2.10 to 2.18)). No infant experienced adverse events; however, bed infants were more frequently considered to be in potentially adverse situations (mean difference (95% CI): bed v stand-alone cot = 0.13 (0.03 to 0.23); side-car crib v stand-alone cot = 0.04 (–0.03 to 0.12); bed v side-car crib = 0.09 (–0.03–0.21)). No differences were observed in duration of maternal or infant sleep, frequency or duration of assistance provided by staff, or maternal rating of postnatal satisfaction.

Conclusion: Suckling frequency in the early postpartum period is a well-known predictor of successful breastfeeding initiation. Newborn babies sleeping in close proximity to their mothers (bedding-in) facilitates frequent feeding in comparison with rooming-in. None of the three sleep conditions was associated with adverse events, although infrequent, potential risks may have occurred in the bed group. Side-car cribs are effective in enhancing breastfeeding initiation and preserving infant safety in the postnatal ward.

See end of article for authors' affiliations

Correspondence to:
H Ball, Department of
Anthropology, Durham
University, 43 Old Elvet,
Durham DH1 3HN, UK;
H.L.Ball@dur.ac.uk

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Although the beneficial effects of early and frequent suckling and skin-to-skin contact on breastfeeding initiation are well known,^{1–6} there has been little work on the effect of subsequent mother–infant contact in the initial postnatal days. Night-time rooming-in has been shown to enhance breastfeeding on demand in comparison with night-time nursery care^{7–8}; however, “rooming-in” involves babies sleeping in stand-alone cots that do not allow continuous contact or spontaneous feeding between mothers and infants. Yet, such contact may be of importance for mothers to understand their babies' signals and to respond effectively.

Unhindered contact can only be provided for mother and baby at night in the postnatal ward through some arrangement whereby both of them can maintain continuous contact to allow spontaneous breastfeeding. Two forms of bedding-in currently practised in UK hospitals include either the baby sleeping in the mother's bed, usually with the provision of removable cot-sides to prevent falls, or the baby sleeping in a side-car crib that is attached to the frame of the mother's bed and is enclosed on three sides, allowing the baby a separate sleep surface, but one that is contiguous with the mother's bed. We also recognised that breastfeeding mothers commonly take their babies into their own beds for feeding, and that both parties often fall asleep in this situation, whether or not this was planned, or advised against by midwives, or whether appropriate cot-sides were provided.

We therefore designed a trial to determine the way in which different degrees of mother–infant contact in the immediate

postnatal period affects infant care, including breastfeeding, and to ascertain whether infant safety is compromised when babies and mothers are in close proximity.

METHODS

Recruitment

After approval from the research ethics committee was obtained, we recruited pregnant women attending antenatal breastfeeding workshops (held once or twice per month) in Newcastle upon Tyne, UK. Those returning completed consent and enrolment forms were entered into the trial if they were healthy, non-smoking first-time mothers, pregnant with a single infant, anticipating a normal vaginal delivery and intending to breastfeed.

Assignment

Recruits were randomly allocated, by a concealed sequence compiled with a random number generator, to one of three sleep conditions: rooming-in with stand-alone cot; bedding-in with a side-car crib; or bedding-in in mother's bed with cot-side. Recruitment, enrolment and anonymous randomisation were conducted by three different members of the research team (KAB, EH and SJL, respectively). Postpartum exclusion criteria included caesarean delivery, ill baby or mother, and receipt of intravenous or intramuscular opiate analgesics in the preceding 24 h. After delivery, the research nurse confirmed each mother's continuing eligibility and willingness to participate in the study.

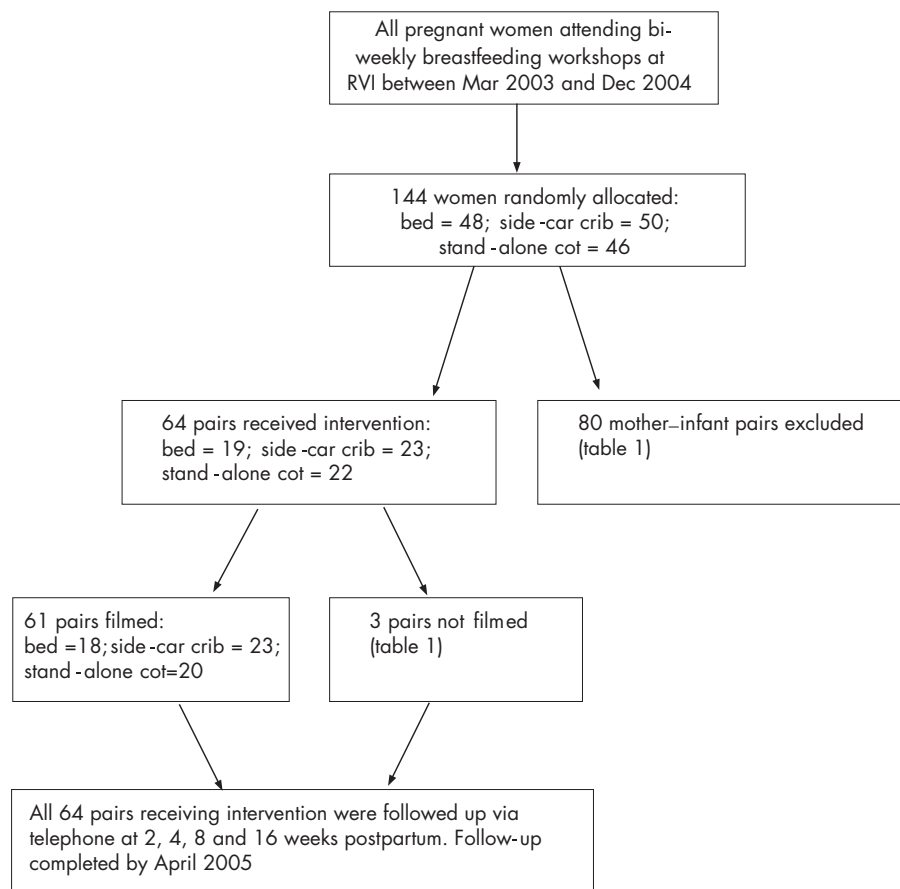


Figure 1 Recruitment and exclusion of participants.

Video protocol

A small camcorder with infrared filming capability was erected atop a 2-m monopod attached to the foot of the mother's bed, with the recorder housed in an attache case placed under the bed. Mothers were provided with a remote control and requested to start the recording whenever they intended to settle down for sleep. The tape recorded for 8 h or until the mother chose to terminate filming. Mothers were requested to keep their baby in the allocated sleep location when they were asleep. We did not specify how or where mothers should feed their infants. Mothers and babies were filmed on the first two postnatal nights.

After filming, we offered mothers the opportunity to view their videotapes as per standard guidelines,⁹ and obtained further consent for the videos to be analysed. Mothers then participated in a semistructured interview regarding their postnatal experience, and we abstracted labour and delivery information from the case notes. On completion of the study, mothers received a £10 gift voucher for baby products and a tape of clips from their two nights of filming (approved by the local National Health Services research ethics committee). We report here on the short-term outcomes.

Masking

We described the study as an infant sleep study to investigate the effects of the three conditions on the postnatal experience generally. True blinding was not possible either for investigators or for participants.

Outcome measures

The outcome on which we powered the study was successful initiation of breastfeeding, defined on the basis of observed

infant behaviour (attempted feeds, successful feeds and feeding effort), but we regarded infant safety as a second primary outcome even though there were no published or unpublished data on which to base a power calculation.

Feeding effort was calculated as the frequency per hour of unsuccessful and successful feeding attempts. Infant safety was determined by assessing the "potential risk exposure": frequency per hour and proportional duration of potentially adverse situations categorised as breathing risk (external airways covered); overheating risk (head completely covered); falling risk (precarious positioning with no means of fall prevention); entrapment risk (wedged between bed and side-rail); and overlaying risk (trapped under mother's torso). Infant safety was monitored according to the hospital's extant bedding-in policy that included regular checks on mothers and infants known to be bedding-in.

Other outcome measures were maternal and infant sleep duration, maternal satisfaction and staff's contact time with the mother.

Sample size

Previous studies of mother-infant sleep contact had found that night-time breastfeeding frequency was three times greater when mothers and infants slept in the same bed than when they slept in separate locations.¹⁰ To observe a difference between bedding-in (bed or side-car crib conditions) and rooming-in (stand-alone cot condition), we used short-term outcomes (feed frequency) as the basis for our power calculations: 28 participants were required in each group to achieve 90% power at 95% precision. Each group required 20 participants to achieve 80% power at the same precision. We aimed, therefore, to obtain data on

Table 1 Reasons for participant exclusion and ineligibility between enrolment and delivery of 144 participants enrolled and randomly allocated

	Bed = 48	Side-car crib = 50	Stand-alone cot = 46
Exclusion after delivery			
Caesarean section	9	14	12
Participant withdrew	1	3	5
Opiate analgesia	3	3	1
Baby unwell	1	0	1
Stillbirth	1	0	0
Mother unwell	1	0	0
Total excluded	16	20	19
Ineligible mothers			
No camera available	2	1	0
No single room available	7	5	3
Missed notification of delivery	4	1	2
Total ineligible	13	7	5
Total excluded/ineligible	29	27	24
Total eligible participants	19	23	22
Total eligible and videotaped	18 dyads	23 dyads	20 dyads

90 mother–infant pairs (30 allocated to each arm of the trial); however, as half of all mothers recruited were excluded due to ineligibility after delivery, 64 mother–infant pairs participated in the intervention.

Analysis

The videotapes of mother–infant behaviour on the first and second postnatal nights were coded using Noldus Observer 5 behavioural analysis software at the University of Durham Parent–Infant Sleep Laboratory (Durham, UK), using behavioural taxonomies developed in previous studies.¹¹ Three researchers coded the videotapes, coding equal proportions of tapes from each condition to minimise any potential observer bias. Interobserver and intraobserver reliability was regularly tested by recoding identical sections of tape to ensure κ scores >90%. Statistical analyses were conducted using SPSS v.10; all analyses used pairwise comparisons between the conditions using parametric or non-parametric tests according to whether or not the data were normally distributed.

RESULTS

Recruitment rate

15–20 pregnant women participated in each of the 35 breastfeeding workshops attended; a mean of 4.1 women from each workshop volunteered for the study. Not all of the women attending workshops were eligible to volunteer for

the trial (multiple pregnancies, scheduled caesarean sections, planned opiate analgesia, planned home delivery), which we estimate reduced the pool of potential volunteers to a mean of 11.5 women per workshop, resulting in an approximate recruitment rate of 35%. We were not able to compare the characteristics of volunteers and non-volunteers owing to lack of consent to access the records of non-volunteers.

Participant flow

Figure 1 shows the recruitment and exclusion of participants in the trial. Table 1 gives a break-down of reasons for exclusion or loss after delivery. Owing to limitation in room availability, late notification, or early discharge, 17 mother–infant dyads were filmed on only one night (nine missed on the first night, eight missed on the second night).

All 61 mothers who participated in filming were interviewed before discharge. A comparison of eligible and ineligible participants found no statistical differences in maternal age, marital status, education and income.

Adherence to the allocated sleeping condition was defined as the infant spending >50% of observed sleep time in the allocated condition per night. Of the 61 participants eligible for analysis, 5 did not adhere to their allocated condition on both nights, and a further 14 did not adhere to the condition one night. All 61 participants who were videotaped were analysed according to their randomly allocated condition (intention-to-treat analysis) regardless of cross-over.

Table 2 Characteristics of the three randomised groups who were videotaped

	Mother's bed (n = 18)	Side-car crib (n = 23)	Stand-alone cot (n = 20)
Mean maternal age (range), years	32.8 (28–39)	31.4 (21–40)	30.9 (22–37)
Mean infant age at filming (range), h	15.4 (3.5–26)	16.6 (6.8–27.5)	17.6 (6.5–28)
Mean gestation length (range), days	283.9 (268–298)	283.2 (270–293)	280.6 (263–292)
Mean birth weight (range), kg	3.3 (2.8–4.0)	3.4 (2.6–4.3)	3.5 (2.9–4.3)
Ethnicity, n (%)			
White European	16 (89)	22 (96)	29 (95)
Asian	2 (11)	1 (4)	1 (5)
Labour, n (%)			
Spontaneous	16 (89)	17 (77)	16 (80)
Induced	2 (11)	5 (22)	4 (20)
Median 5-min APGAR (range)	9 (8–10)	9 (9–10)	9 (9–10)
Median time at delivery since previous maternal sleep (range), h	36.0 (20–60)	36.0 (4–96)	36.0 (12–72)
Median duration of maternal sleep after delivery before filming (range), h	0.3 (0–8)	1.3 (0–8)	0.8 (0–6)
Mean duration of initial breastfeeding opportunity on delivery suite (range), min	25.0 (5–60)	19.0 (5–90)	23.0 (5–35)

APGAR, Appearance, Pulse, Grimace, Activity and Respiration.

Participants who crossed over from bed to stand-alone cot, side-car crib to bed and stand-alone cot to bed did so of their own preference. Table 2 provides the baseline demographic and clinical characteristics of the three intervention groups.

Primary outcomes

We analysed data by “intention to treat”. Mothers and babies allocated to the bed and side-car crib conditions made considerably more attempts to feed (both successful and unsuccessful) and exhibited more feeding effort than babies allocated to the stand-alone cot, but there was no difference between infants allocated to the bed and side-car crib (table 3).

None of the 61 infants experienced adverse events or side effects in the course of this study. However, we observed potential risk events for two of the six predefined hypothetical risk categories: breathing risk and falling risk. Potential breathing risk, but not falling risk, was recorded significantly more often and for a significantly greater duration in the bed condition than in the side-car crib or stand-alone cot conditions.

Other outcomes

Maternal and infant sleep duration, maternal satisfaction and the amount of staff contact time with the mother were analysed (table 4). The median proportional sleep duration (range) for mothers was 64.5% (11.8–99.8%) and that for infants was 65.9% (6.5–99.8%). Maternal satisfaction scores were below the midpoint of the scale for mothers allocated to the stand-alone cot condition and above the midpoint for mothers allocated to the bed and side-car crib conditions, but none of the differences were significant. We assessed demands on staff time in three ways: frequency per hour of calls made to staff by mothers, frequency per hour of visits to mothers by ward staff, and duration of staff visits. Mothers allocated to the bed and side-car crib conditions called staff significantly more frequently than mothers allocated to the stand-alone cot condition; however, we found no differences in the frequency or duration of visits to mothers made by staff.

DISCUSSION

The results of this randomised trial of three infant sleep locations on the postnatal ward show the benefits of unhindered mother–infant contact on the initiation of breastfeeding during the immediate postnatal period. Mothers and infants experiencing unhindered opportunity for night-time breastfeeding showed greater breastfeeding

effort, both in attempting to feed and in feeding successfully more often, than when the infants were physically separated by sleeping in a plastic bassinet (stand-alone cot).

The importance of the frequency of both successful and unsuccessful feeding attempts in the early postnatal period has long been recognised as a key factor in establishing milk production and in learning how to suckle,^{2 12–14} with the frequency of night-time feeds being of particular significance.¹⁵ High prolactin levels are critical for breastfeeding initiation, and successful long-term lactation depends on the development of sufficient prolactin receptors during this initial period, which depends on frequent feeding.¹⁶ Any intervention that increases feeding frequency in the early postpartum period, therefore, has the potential to affect not just breastfeeding initiation but also long-term breastfeeding duration (unpublished data).

Regarding infant safety, we found that infants were exposed to potentially hazardous situations (in the form of airway covering) more often when allocated to their mothers' beds than when allocated to the side-car crib or stand-alone cot. It is important to acknowledge that all situations identified as potential risks were made using the judgement of the observers coding the videotapes, and it is possible that episodes seeming to be a risk on camera may have seemed otherwise from the vantage point of someone in the room. This possibility is supported by the observation that during one episode coded as a potential risk (due to a mother's arm apparently resting across her infant's face) a midwife entered the room, checked on the sleeping pair, and left again. What seemed as a risk from our camera angle did not seem to alarm the midwife; however, the event remained in the coded data as a potential risk, and therefore contributed to the final outcomes.

We also emphasise that as we observed no actual risks, we have no means of assessing the likelihood of a potential risk becoming a real one; none of the infants in this study experienced any adverse effects relating to their experience of potential risks. The infant allocated to the bed condition who experienced the greatest frequency of potential breathing risks was a case of cross-over from the bed to the stand-alone cot, all of whose observed bouts of airway covering occurred while sleeping in the stand-alone cot and were all related to swaddling. This shows that the stand-alone cot environment is not free from potential hazards.

Other analysis of maternal and infant sleep duration on the first and second postnatal nights showed no differences in sleep duration across conditions. Despite the common

Table 3 Breastfeeding outcome and potential risk events by allocated sleep condition

	Bed, n = 18	Side-car crib, n = 23	Stand-alone cot, n = 20	Bed v stand-alone cot		Side-car crib v stand-alone cot		Bed v side-car crib	
				Mean difference (95% CI)	p Value (Mann–Whitney U)	Mean difference (95% CI)	p Value (Mann–Whitney U)	Mean difference (95% CI)	p Value (Mann–Whitney U)
Median frequency per h (range)									
Attempted feeds	1.3 (0.0–1.5)	2.1 (0.0–9.1)	0.7 (0.0–6.9)	1.87 (0.63 to 3.11)	0.012	1.57 (0.58 to 2.57)	0.008	0.30 (–1.12 to 1.72)	0.64
Successful feeds	1.2 (0.0–6.0)	1.3 (0.0–7.3)	0.5 (0.0–6.6)	0.90 (0.19 to 1.61)	0.003	0.96 (0.18 to 1.73)	0.013	–0.06 (–0.95 to 0.83)	0.93
Feeding effort	2.5 (0.0–17.5)	3.4 (0.0–14.3)	1.3 (0.0–12.9)	2.56 (0.72 to 4.41)	0.008	2.52 (0.87 to 4.17)	0.006	0.04 (–2.10 to 2.18)	0.97
All potential risk	0.0 (0.0–1.0)	0.0 (0.0–1.2)	0.0 (0.0–0.6)	0.13 (0.03 to 0.23)	0.100	0.04 (–0.03 to 0.12)	0.196	0.09 (–0.03 to 0.21)	0.006
Breathing risk	0.0 (0.0–1.0)	0.0 (0.0–0.6)	0.0 (0.0–0.6)	0.11 (0.01 to 0.21)	0.158	0.02 (–0.03 to 0.07)	0.328	0.09 (–0.01 to 0.19)	0.027
Falling risk	0.0 (0.0–0.5)	0.0 (0.0–0.6)	0.0 (0.0–0.0)	0.02 (–0.01 to 0.06)	0.858	0.02 (–0.12 to 0.06)	0.166	0.002 (–0.05 to 0.51)	0.125
Median proportional (%) duration (range)									
All potential risk	0.0 (0.0–13.3)	0.0 (0.0–2.3)	0.0 (0.0–6.0)	1.03 (–0.07 to 2.12)	0.145	–0.05 (–0.40 to 0.30)	0.118	1.08 (0.06 to 2.10)	0.007
Breathing risk	0.0 (0.0–13.3)	0.0 (0.0–1.3)	0.0 (0.0–6.0)	0.92 (–0.16 to 1.99)	0.130	–0.12 (–0.44 to 0.21)	0.355	1.04 (0.05 to 2.02)	0.030
Falling risk	0.0 (0.0–0.5)	0.0 (0.0–0.2)	0.0 (0.0–0.0)	0.02 (–0.02 to 0.06)	0.835	0.01 (–0.00 to 0.02)	0.166	0.01 (–0.02 to 0.05)	0.125

Table 4 Comparison of sleep, satisfaction and staff time across the three sleeping conditions

	Bed, n = 18	Side-car crib, n = 23	Stand-alone cot, n = 20	Bed v stand-alone cot		Side-car crib v stand-alone cot		Bed v side-car crib	
	Median proportional duration (range)			Mean difference (95% CI)	p Value (Mann–Whitney U)	Mean difference (95% CI)	p Value (Mann–Whitney U)	Mean difference (95% CI)	p Value (Mann–Whitney U)
Maternal sleep duration	59.4 (18.7–98.2)	65.6 (11.8–98.2)	66.7 (12.5–99.8)	–0.29 (–11.0 to 10.4)	0.499	–5.26 (–15.8 to 5.2)	0.287	4.97 (–4.6 to 14.6)	0.642
Infant sleep duration	64.6 (20.6–99.8)	66.6 (6.5–98.1)	67.2 (22.8–98.6)	–2.87 (–13.5 to 7.7)	0.962	–5.29 (–16.0 to 5.4)	0.375	2.42 (–8.3 to 13.1)	0.513
	Mean score (SD)				p Value (t test)		p Value (t test)		p Value (t test)
Maternal satisfaction	3.1 (1.1)	3.2 (0.9)	2.8 (0.8)	0.39 (–0.2 to 1.0)	0.217	0.46 (–0.9 to 1.0)	0.096	–0.08 (–0.7 to 0.6)	0.820
Mean frequency per hour (SD)									
Calls to staff (frequency/h)	0.13 (0.2)	0.17 (0.3)	0.03 (0.1)	0.10 (0.02 to 0.2)	0.017	0.14 (0.03 to 0.24)	0.010	–0.03 (–0.2 to 0.1)	0.617
Visits by staff (frequency/h)	0.40 (0.5)	0.35 (0.6)	0.28 (0.7)	0.12 (–0.17 to 0.41)	0.401	0.06 (–0.22 to 0.35)	0.654	0.05 (0.2 to 0.3)	0.657
Mean proportional duration (SD)									
Duration of visits by staff	2.12 (3.6)	1.25 (1.9)	1.05 (3.6)	1.1 (–0.7 to 2.8)	0.233	0.20 (–1.1 to 1.6)	0.763	0.87 (–0.5 to 2.2)	0.205

argument that mothers need an uninterrupted night's sleep after delivery to aid recuperation, two studies^{17–18} found that rooming-in mothers obtained no more or less sleep on their initial postpartum nights than did mothers whose infants were consigned to a hospital nursery. To this, we can now add further evidence that the degree of mother–infant proximity does not affect postnatal sleep duration, even to the point of the infant sharing the mother's bed.

It is normal practice in randomised trials that all participants who are allocated to a randomised condition are followed up and included in the data analysis, regardless of whether they subsequently dropped out of the trial. However, in this study, owing to the ethical requirement that mothers be randomised before delivery, we experienced a high post-randomisation exclusion rate due to delivery and postnatal factors; hence, we confined the analysis to the actual participants. This has the potential to bias the results if the exclusions disproportionately cluster in certain randomised groups. Analysis of the effects of the exclusions on the overall sample showed that the study had lower power than originally intended, but as the exclusions were equally distributed across the randomly allocated conditions no disproportionate clustering could be observed. The results may still reflect bias if the exclusions differed from the participants in some systematic way that we have been unable to assess.

The results of this study can be generalised only to mothers and infants experiencing vaginal deliveries without the receipt of opiate analgesia in the preceding 24 h. The effect of opiates on infant behaviour is known to be profound,^{19–22} and we were sufficiently wary of their effects on maternal awareness to consider the use of opiates within 24 h to be a contraindication for either of the bedding-in conditions.²³ Likewise, these results cannot be generalised to mothers and infants experiencing caesarean section delivery due to the complicating effects of caesarean section on breastfeeding initiation, mother–infant interaction and maternal sleep.^{24–26}

As equally frequent feeding took place in both the side-car crib and mother's bed, and the potential for infant risks was equally low for both the side-car crib and stand-alone cot, the side-car crib emerges as the most effective postnatal ward sleeping environment for infants in optimising both breastfeeding initiation and infant safety. Bedding-in with the

infant in the mother's bed was effective in breastfeeding initiation. Limitations of the fixed camera angle used in this study in facilitating assessment of potentially hazardous events means that the bed condition may be shown to be an equally sound option with further study. Future studies to examine the effects of the postnatal use of a side-car crib on breastfeeding duration and on breastfeeding initiation in groups of mothers with high rates of breastfeeding failure (such as caesarean section) are in progress.

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What is already known on this topic

- Frequent suckling and skin-to-skin contact after delivery enhances breastfeeding initiation, and mother–infant sleep contact is commonly practised at home by breastfeeding mothers.
- Rooming-in facilitates breastfeeding on demand in comparison with nursery care, but does not allow continuous mother–infant contact or spontaneous suckling.

What this study adds

- This study examines two forms of mother–infant sleep contact (baby in bed and baby in side-car crib) on the postnatal ward and shows increased night-time feeding frequency in bed and side-car crib conditions, where both mother and infant experience unhindered access.
- Use of side-car cribs in the postnatal ward increases breastfeeding frequency, while maintaining infant safety.

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Authors' affiliations

H L Ball, Parent-Infant Sleep Laboratory & Medical Anthropology Research Group, Department of Anthropology, Durham University, Durham, UK

M P Ward-Platt, Newcastle Neonatal Service, Royal Victoria Infirmary, Newcastle upon Tyne, UK

E Heslop, S J Leech, Parent-Infant Sleep Laboratory, Department of Anthropology, Durham University

K A Brown, Midwifery Services, Royal Victoria Infirmary, Newcastle upon Tyne

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